

Appl. No. 10/683,612
Examiner: Kennedy, Jennifer M, Art Unit 2812
In response to the Office Action dated February 8, 2005

Date: April 22, 2005
Attorney Docket No. 10112981

REMARKS

Applicant thanks the Examiner for acknowledging Applicant's claim to foreign priority and receipt of the certified copy of the priority document. Responsive to the Office Action mailed on February 8, 2005 in the above-referenced application, Applicant respectfully requests amendment of the above-identified application in the manner identified above and that the patent be granted in view of the arguments presented. No new matter has been added by this amendment.

Present Status of Application

After this amendment, claims 1-11 and 13-20 are pending. Claims 6 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 1, 2, 5-12, and 15-20 are rejected under 35 U.S.C 103(a) as being unpatentable over Youn et al. (U.S. Patent Appl. 2004/0238876) in view of Yang (U.S. Patent Appl. 2002/0074584). Claims 3-4 and 13-14 are rejected under 35 U.S.C 103(a) as being unpatentable over Youn et al and Yang in view of Cantell et al (U.S. Patent No. 6,255,179).

In this paper, claims 6 and 16 are amended to recite the thickness of the metal-flash layer. Claim 1 is amended to recited forming a tungsten layer overlying the annealed tungsten nitride layer. Support for this amendment can be found within the claim itself and on page 5, line 21 to page 6, line 7 of the specification. Claim 11 is amended to recite the limitation found in dependent claim 12. Claim 12 is canceled.

Reconsideration of this application is respectfully requested in light of the amendments and the remarks contained below.

Rejections Under 35 U.S.C 112

Claims 6 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 6 and 16 have been amended to recite the thickness of the *metal-flash* layer, an element that finds antecedent basis in claims 1 and 11, respectively.

Applicant therefore submits that the rejections of claims 6 and 16 under 35 U.S.C. 112 are overcome and respectfully requests the withdrawal of said rejections.

Rejections Under 35 U.S.C. 103(a)

Claims 1, 2, 5-12, and 15-20 are rejected under 35 U.S.C 103(a) as being unpatentable over Youn et al in view of Yang. Claims 3-4 and 13-14 are rejected under 35 U.S.C 103(a) as being unpatentable over Youn et al. and Yang in view of Cantell et al. To the extent that the grounds of the rejections may be applied to the claims now pending in this application, they are respectfully traversed.

Youn et al disclose a method for forming a metal-polysilicon gate stack 112 comprising an impurity-doped polysilicon layer 104, a tungsten silicide (WSix) layer 106, a tungsten-nitride (WN) layer 108, and a tungsten layer 110. Please see sections [0022] to [0031] and Figs. 3A-3D of Youn et al.

The tungsten silicide (WSix) layer 106 may be formed by heat-treating a tungsten layer in ambient nitrogen (N₂). See section [0025] of Youn et al.

The WN layer 108 is formed by a sputtering process, a CVD process, or an ALD process. In a sputtering process, a WN layer may be deposited with an N₂ flow rate of 33 sccm. See section [0027] of Youn et al. Note that the tungsten-nitride (WN) layer 108 is formed by deposition using N₂ as a process gas. There is no teaching of annealing the WN layer using N₂ and/or H₂.

The tungsten layer 110 is formed on WN layer 108 by a sputtering process, a CVD process, or an ALD process. See section [0029] of Youn et al. Youn et al then goes on to teach that the structure may undergo "subsequent high temperature annealing processing." See section [0031] of Youn et al.

Yang discloses a backend wafer processing on a capacitor (including a bottom electrode 245, a buffer layer 250, a dielectric layer 255, and a top electrode 265) overlying a word line (gate) 202

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or 204. The word line 202 or 204 includes a polysilicon layer 216, a tungsten nitride layer 218, a metal layer 220, and a cap layer 222. Moreover, the backend processing typically includes annealing the wafer in an ambient of 10% H₂ and 90% N₂. Please see sections [0033] and [0072] and Figs. 2A and 2I. of Yang.

Neither Youn et al nor Yang, when taken alone or in combination, teach or suggest a method for fabricating a semiconductor device having a stacked-gate structure, comprising the steps of forming a tungsten nitride layer overlying a metal-flash layer, annealing the tungsten nitride layer using nitrogen and hydrogen gases, and forming a tungsten layer overlying the annealed tungsten nitride layer, as recited in claim 1.

Claim 1 recites annealing the tungsten nitride layer using nitrogen and hydrogen gases, and then forming a tungsten layer overlying the annealed tungsten nitride layer. As noted in the specification, annealing performed using nitrogen and hydrogen gases after the formation of the tungsten nitride layer increases thermal stability and reduces resistance of the stacked gate structure, thereby increasing device reliability. See page 6, line 27 to page 7, line 2 of the specification.

MPEP 2142 reads in part:

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In connection with the third criteria, MPEP 2143.03 goes on the state:

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970).

In the rejection of claim 1, the Examiner relies upon Youn et al to teach "forming a tungsten nitride layer (108)" and "forming a tungsten layer (110) overlying the tungsten nitride layer." The office action goes on to state "Youn et al disclose the method of annealing the tungsten and the tungsten nitride layer utilizing nitrogen, but do not disclose the method wherein the tungsten and tungsten nitride layers are annealed using nitrogen and hydrogen gases." Yang is relied upon to teach the method of annealing a tungsten layer and a tungsten nitride layer of gate stack using nitrogen and hydrogen gases. See page 3 of the office action.

Applicant first notes that claim 1 does not recite "annealing the tungsten and the tungsten nitride layer" as stated in the office action. Instead, claim 1 recites the steps of 1) annealing the tungsten nitride layer using nitrogen and hydrogen gases; and then 2) forming a tungsten layer overlying the **annealed** tungsten nitride layer.

Youn et al do not teach the steps of annealing the tungsten nitride layer using nitrogen and hydrogen gases prior to the formation of a tungsten layer. In Youn et al, the tungsten-nitride (WN) layer 108 is formed by deposition using N₂ as a process gas. One of ordinary skill in the art would know that deposition is a different process from annealing. Applicant notes that the Examiner refers to section [0047] of Youn et al in connection with the rejections of claim 9 reciting that the tungsten nitride layer is annealed at 800 to 1000°C. However, section [0047] of Youn et al teaches annealing **after** deposition of the tungsten (W) layer.

Yang also fails to teach or suggest the tungsten nitride layer is annealed using nitrogen and hydrogen gases during formation of the stack-gate structure. In this regard, Applicant notes that backend processing means the process is performed during metallization or passivation or after, rather than during the fabrication of a transistor or a gate structure. That is, any process performed during the fabrication of a transistor or gate structure is called front-end processing,

rather than back-end processing. Accordingly, neither a tungsten layer nor the tungsten nitride layer 218 is subjected to annealing using H₂ and N₂ during the fabrication of the word line (gate) 202 or 204 in Yang.

As neither Youn et al nor Yang, when taken alone or in combination, teach or suggest all the limitations recited in claim, it is Applicant's belief that claim 1 is allowable over the cited references. Insofar as claims 2-10 depend from claim 1, it is Applicant's belief that they are also in condition for allowance by virtue of their dependency from claim 1. For this reason, the Examiner's arguments in connection with these claims are considered moot and will not be addressed here.

Neither Youn et al nor Yang, when taken alone or in combination, teach or suggest a method for fabricating a semiconductor device having a stacked-gate structure, comprising the steps of forming a tungsten nitride layer overlying a metal-flash layer, forming a tungsten layer overlying the tungsten nitride layer, annealing the tungsten layer and the tungsten nitride layer using nitrogen and hydrogen gases, and forming a cap layer overlying the annealed tungsten layer, as recited in claim 11.

For at least the reasons discussed in connection with claim 1, Applicants respectfully asserts that neither Youn et al nor Yang, whether taken alone or in combination, teach or suggest annealing the tungsten layer and the tungsten nitride layer using nitrogen and hydrogen gases, and forming a cap layer overlying the annealed tungsten layer. Namely, neither Youn et al nor Yang teach forming a cap layer overlying the **annealed** tungsten layer. Furthermore, neither Youn et al nor Yang teaches or otherwise discloses the tungsten layer and the tungsten nitride layer are annealed using nitrogen and hydrogen gases during formation of the stack-gate structure.

As neither Youn et al nor Yang, when taken alone or in combination, teach or suggest all the limitations recited in claim, it is Applicant's belief that claim 11 is allowable over the cited references. Insofar as claims 13-20 depend from claim 11, it is Applicant's belief that they are also in condition for allowance by virtue of their dependency from claim 11. For this reason, the

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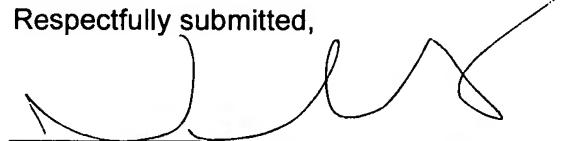
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Examiner's arguments in connection with these claims are considered moot and will not be addressed here.

Conclusion

The Applicant believes that the application is now in condition for allowance and respectfully requests so.

Respectfully submitted,



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